State General Revenue Nonpoint Source Grant Program

Instream Bacteria Influences from Bird and Bat Habitation of Bridges

TSSWCB Project 11-51

Quality Assurance Project Plan

Revision No. 2

Texas State Soil and Water Conservation Board

Prepared by

Texas Institute for Applied Environmental Research

Stephenville, Texas

Effective Period: Approval through July 31, 2013

(Annual updates required)

Questions concerning this quality assurance project plan should be directed to:

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Stephenville, Texas 76402

A1 Approval Sheet

Texas State Soil and Water Conservation Board (TSSWCB)

Wesley Gibson Project Manager	Date	Pamela Casebolt Quality Assurance Officer	Date

Texas Institute for Applied Environmental Research (TIAER)

Nikki Jackson Project Manager	Date	Larry Hauck Lead Scientist	Date
Nancy Easterling TIAER Project Quality Assurance Officer	Date	Mark Murphy TIAER Laboratory Manager & LQAO	Date
David Pendergrass Field Operations Supervisor	Date		

A2 Table of Contents

A3 Distribution List

Organizations, and individuals within, which will receive copies of the approved QAPP and any subsequent revisions include:

Texas State Soil and Water Conservation Board
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Temple, Texas 76503-0658

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Pamela Casebolt, Quality Assurance Officer
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David Pendergrass, Field Operations Supervisor
(254) 968-1851

Mark Murphy, TIAER Laboratory Manager & LQAO
(254) 968-9570

Nancy Easterling, TIAER Project QAO
(254) 968-9548

Texas AgriLife Research – Soil and Crop Sciences Department (SCSC)
Soil and Aquatic Microbiology Lab (SAML)
2474 TAMU
College Station, TX 77843

Terry Gentry, Lab Manager
(979) 845-5323

LIST OF ACRONYMS

AWRL	Ambient Water Reporting Limit
BST	Bacterial Source Tracking
CAR	Corrective Action Report
CMS	Coordinated Monitoring Schedule
COC	Chain-of-Custody
CRP	Clean Rivers Program
CWA	Clean Water Act
DOC	Demonstration of Capability
DQO	Data Quality Objective
DMRG	Data Management Reference Guide
EPA	U.S. Environmental Protection Agency
ERIC-PCR	Enterobacterial Repetitive Intergenic Consensus Polymerase Chain Reaction
ERIC-RP	ERIC-PCR / RiboPrinting Combination Method
FY	Fiscal Year
GM	General Maintenance
LCS	Laboratory Control Sample
LIMS	Laboratory Information Management System
LOQ	Limit of Quantitation
LQAO	Laboratory Quality Assurance Officer
NELAP	National Environmental Laboratory Accreditation Program
NIST	National Institute of Standards and Technology
NPS	Nonpoint Source
PCR	polymerase chain reaction
PM	Project Manager
QA	Quality Assurance
QAM	Quality Assurance Manual
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	Quality Control
QPR	Quarterly Progress Report
RL	Reporting Limit
SAML	Soil and Aquatic Microbiology Laboratory
SCSC	Department of Soil and Crop Sciences, Texas AgriLife Research
SOP	Standard Operating Procedure
SLOC	Station Location Request
SWQM	Surface Water Quality Monitoring
SWQMIS	Surface Water Quality Monitoring Information System
TIAER	Texas Institute for Applied Environmental Research
TMDL	Total Maximum Daily Load
TCEQ	Texas Commission on Environmental Quality
TSSWCB	Texas State Soil and Water Conservation Board
TSWQS	Texas Surface Water Quality Standards
USGS	United States Geological Survey
WPP	Watershed Protection Plan

A4 Project/Task Organization

Texas State Soil and Water Conservation Board, Temple, Texas – Provides project oversight at the State level.

Wesley Gibson, Project Manager
Maintains a thorough knowledge of work activities, commitments, deliverables, and time frames associated with project. Develops lines of communication and working relationships between TIAER and TSSWCB. Tracks deliverables to ensure that tasks are completed as specified in the contract. Responsible for ensuring that the project deliverables are submitted on time and are of acceptable quality and quantity to achieve project objectives. Participates in the development, approval, implementation, and maintenance of the QAPP. Assists the TSSWCB QAO in technical review of the QAPP. Responsible for verifying that the QAPP is followed by project participants. Notifies the TSSWCB QAO of particular circumstances that may adversely affect the quality of data derived from the collection and analysis of samples. Ensures distribution of approved/revised QAPPs to project partners. Enforces corrective action.

Pamela Casebolt, Quality Assurance Officer
Reviews and approves QAPP and any amendments or revisions and ensures distribution of approved/revised QAPPs to TSSWCB and project participants. Responsible for verifying that the QAPP is followed by project participants. Determines that the project meets the requirements for planning, QA, QC, and reporting. Monitors implementation of corrective actions. Coordinates or conducts audits of field and laboratory systems and procedures.

Texas Institute for Applied Environmental Research, Tarleton State University, Stephenville, Texas
Responsible for general project oversight, coordination, administration, data collection, analyses and reporting, and development of project DQOs and QAPP.

Nikki Jackson, Project Manager
Responsible for implementing and monitoring TSSWCB requirements in contracts, QAPPs, and QAPP amendments and appendices. Coordinates project planning activities and work of project partners. Responsible for coordinating attendance at conference calls, training, meetings, and related project activities with the TSSWCB. Responsible for verifying the QAPP is followed and the project is producing data of known and acceptable quality. Notifies the TSSWCB project manager of particular circumstances that may adversely affect the quality of data derived from the collection and analysis of samples. Enforces corrective action. Responsible for assessing the quality of participant work; and submitting accurate and timely deliverables to the TSSWCB Project Manager.

Larry Hauck, Lead Scientist
Responsible for supervising project monitoring activities, including selection of stations and scheduling of surveys. Responsible for designing the bacteria survey protocols. Responsible for ensuring that personnel involved in data collection and assessment are adequately trained and have a thorough knowledge of the QAPP. Responsible for ensuring that all QA/QC requirements of the QAPP are met, documentation related to data collection and analysis is complete and adequately maintained, and that

results are reported accurately. Responsible for ensuring that corrective actions are implemented, documented, reported and verified.

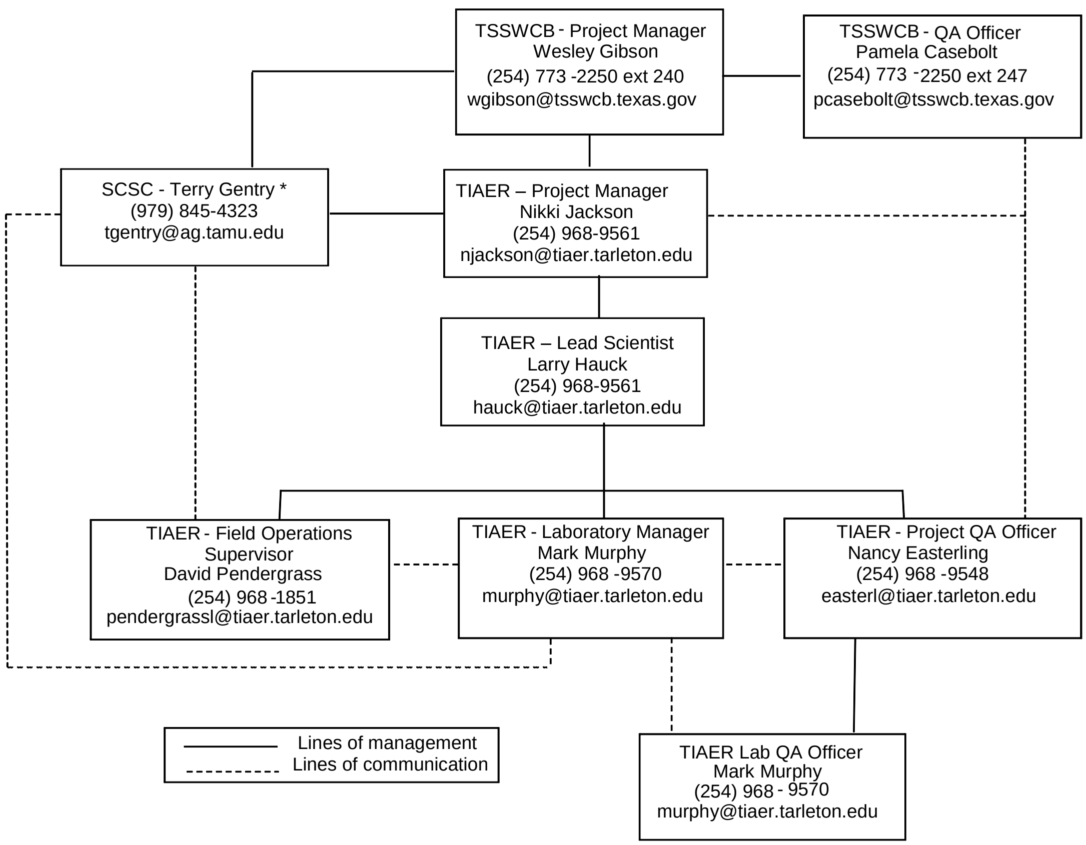
David Pendergrass, Field Operations Supervisor
Responsible for supervising all aspects of sample collection and handling, collection of field data, completion of field documentation, transportation of samples, and other field activities. Responsible for the acquisition of water samples, known source bacteria samples, and field data measurements in a timely manner that meet the DQOs specified in Section A7 (Table A7.1), as well as the requirements of Sections B1 through B8. Responsible for field scheduling, staffing, and ensuring that staff is appropriately trained as specified in Sections A6 and A8.

Nancy Easterling, Project Quality Assurance Officer
Responsible for coordinating development and implementation of the non-laboratory QA program. Participates in planning, development, approval, implementation, and maintenance of the QAPP. Responsible for maintaining records of QAPP distribution, including appendices and amendments. Responsible for identifying, receiving, and maintaining project QA records. Responsible for coordinating with the TSSWCB QAO to resolve QA-related issues. Notifies the TIAER Project Manager of particular circumstances that may adversely affect the quality of data. Responsible for ensuring that corrective actions are implemented, documented, reported and verified. Responsible for validation and verification of all TIAER generated data collected according to Table A7.1 and QC specifications. Coordinates the research and review of technical QA material and data related to water quality monitoring system design.

Mark Murphy, Laboratory Manager
Responsible for supervision of laboratory personnel involved in generating analytical data for this project, excluding bacterial source tracking (BST) data. For BST samples, responsible for coordinating preprocessing and shipping of samples to SCSC (Texas AgriLife Research – Soil and Crop Sciences Department) for analysis. Responsible for ensuring that laboratory personnel involved in generating analytical data have adequate training and a thorough knowledge of the QAPP and all SOPs specific to the analyses or task performed and/or supervised. Responsible for oversight of all operations, ensuring that all QA/QC requirements are met, and documentation related to the analysis is completely and accurately reported. Enforces corrective action, as required.

Mark Murphy, Laboratory QAO
Monitors the implementation of the QAM and the QAPP within the laboratory to ensure complete compliance with QA objectives as defined by the contract and in the QAPP. Conducts internal audits to identify potential problems and ensure compliance with written SOPs. Responsible for supervising and verifying all aspects of the QA/QC in the laboratory. Performs validation and verification of data before data are evaluated to assess project objectives. Insures that all QA reviews are conducted in a timely manner from real-time review at the bench during analysis to final pass-off of data to the QAO. Conducts in-house audits to ensure compliance with the approved QAPP and identify potential problems. Develops and facilitates internal monitoring systems audits.

Figure A4.1. Project Organization Chart



* Dr. Gentry is included in the organizational chart to indicate the communication lines needed to provide known and unknown source samples to his laboratory.

A5 Problem Definition/Background

Bridge crossings often afford a place of ready convenience and safe access for water quality sample collection of streams and rivers. The representativeness of ambient water samples collected from bridge crossings is, however, at times brought into question during public meetings and other forums. The questions typically arise where there is a concern that there might be a bias toward more elevated pollutant concentrations in the immediate vicinity of bridges as compared to river reaches not immediately influenced by bridge crossings. The additional pollutants are derived from birds and bats roosting and nesting on the bridge structures that can occur at some bridge locations.

Water quality specialists recognize the potential legitimacy of the concern of bias from sample location, but must weigh that concern against other factors that include personnel safety, cost, and ease of access. To minimize against any possible biases, the general practice is to sample from the upstream side of the bridge whenever safety issues do not necessitate sampling from the downstream side.

One area of water quality studies where this issue of potential bias toward elevated pollutant levels is often vocalized, especially by stakeholders and local citizenry, is during watershed planning efforts to develop Total Maximum Daily Loads (TMDLs) or Watershed Protection Plans (WPPs) addressing bacterial contamination and recreational use attainment. Because fecal material of bat and bird species that may nest and roost on bridges contains bacteria, such as the state's freshwater indicator bacteria *Escherichia coli* (*E. coli*), at concentrations multiple orders of magnitude higher than ambient water criteria and because bacteria concentrations may rapidly decrease in concentration downstream of sources due to settling and die-off, there seems to be some legitimacy to the concerns being vocalized.

There is a broadly recognized concern that collection of water samples from a bridge represents the potential of collecting a sample with higher levels of pollutants than contained in waters removed from proximity to a bridge crossing. This concern of higher pollutant levels is especially pertinent regarding bacteria sampling where direct deposition of fecal material from bat and bird species inhabiting the bridge can contain bacteria concentrations multiple orders-of-magnitude higher than relevant water quality criteria.

The results of this project have the potential to prove or disprove sampling bias for bacteria collected from bridge locations under certain environmental conditions, which in turn has implications on the validity of the bacteria data used in the 305(b) assessment process and cascading implications on the validity of some waterbodies on the 303(d) list and those waterbodies needing NPS abatement efforts in their watersheds. Further, the results of the project have the potential to inform the selection of stream sampling locations in future projects to minimize potential biases in bacteria results.

This project is designed to occur in the Lampasas and Leon River watersheds due to the prevalence of bacteria impairments in both watersheds. The 2008 303(d) list included bacterial impairments for the several assessment units of the Leon River below Proctor Lake as well as several of its tributaries and for two assessment units of the Lampasas River above Stillhouse Hollow Lake.

A6 Project/Task Description

The overall goal of this project is to develop and implement an experimental study design providing for the collection of environmental data to test the hypothesis that bridges containing significant numbers of roosting and nesting birds and bats increase ambient bacteria concentrations of streams under low flow conditions as compared to the situation where roosting and nesting are absent. Because of difficulties in accurately determining bat populations at bridges, preference will be given in this study to bridges with bird habitation only.

The project objective is to collect environmental data of sufficient quantity and quality to allow assessment of the effects of bird and bat habitation under bridges on *E. coli* concentrations under low flow conditions.

Direct data collection activities are outlined below:

- TIAER will conduct water quality monitoring during survey events spread across the two project years at 3 bridge crossings collecting field, flow, and bacteria parameter groups under biased flow conditions (low flow not influenced by stormwater runoff). A total of 21 survey events will occur. Multiple water samples (15) will be collected from 3 locations (upstream of bridge, upstream edge of bridge, downstream of bridge) during each survey for bacteria analysis only. Field and flow parameters will only be collected once at the location most conducive to accurate flow measurement at each bridge during each survey. The number of bacteria water samples planned for collection is 945.

- TIAER will deploy frames for measuring direct fecal matter deposition and directly quantify the deposition by counting droppings in coordination with the survey events. The deployment and quantification will occur at each bridge during each survey. Four frames will be deployed upstream of the bridge and four downstream with the frames at various distances from the bridge and as near the stream as bank slope and other conditions allow.

- TIAER will inventory birds and bats inhabiting the three study bridge crossings, including species identification and population counts.

Activities not involving direct data collection are as follows:

- TIAER will conduct a literature search for refereed journal articles, technical reports, and other publications that examine the fecal loading rates and instream bacteria influences of birds and bats inhabiting bridges. TIAER will consult with the Center for Research in Water Resources at the University of Texas at Austin and the Texas Department of Transportation to include publications they may have found. Results of literature shall be included in the Final Report.

- TIAER will conduct reconnaissance trips in the Leon River and Lampasas River watersheds to determine the specific bridge locations where monitoring will be conducted. Two bridges will be selected that host roosting or nesting populations of birds and/or bats and one bridge will be selected as a control with either an absence or minimal presence of birds and bats.

TIAER will collaborate with the SCSC, through TSSWCB project 10-50 *Support Analytical Infrastructure and Further Development of a Statewide Bacterial Source Tracking Library*, to conduct BST in the study area to assess and identify different sources contributing to bacteria loadings. Within the SCSC project library-independent BST utilizing the *Bacteroidales* PCR genetic test will be combined with limited library-dependent BST utilizing the ERIC-RP combination method. The Texas *E. coli* BST Library will also be supplemented with known fecal samples from the study area. Direct data collection for the BST and known source samples under the present project covered by this QAPP is outlined below:

- TIAER will store Method 1603 modified mTEC plates, from 90 water samples, at >0°C to ≤6°C for shipment to SCSC. TIAER will coordinate the shipment of these samples with SCSC such that they are received in College Station within 3 days following enumeration. Stored samples may be used by SCSC to conduct library-dependent BST and analyze *E. coli* isolates utilizing Enterobacterial Repetitive Intergenic Consensus PCR (ERIC-PCR) and/or RiboPrinting methods. These 90 water samples represent a subset of the 945 water samples to be collected during the study.

- The Texas *E. coli* BST Library needs to be supplemented with known fecal samples from the study area. TIAER will deliver to SCSC up to 20 known source fecal samples collected for possible addition to the BST library. Fecal samples will be stored at >0°C to ≤6°C and shipped to SCSC for analysis. TIAER will coordinate the shipment of these samples with SCSC such that they are received in College Station within 3 days of collection.

Table A6.1. Schedule of Milestones

Task	Project Milestones	Start[1]	End[2]
2	**Quality Assurance**		
2.1	QAPP development and approval by the TSSWCB	Month 1	Month 3
2.2	Implement approved QAPP and submit revisions and amendments	Month 4	Month 23
3	**Conduct Monitoring**		
3.1	Conduct literature review	Month 1	Month 6
3.2	Conduct reconnaissance	Month 1	Month 3
3.3	Conduct water quality monitoring	Month 4	Month 22
3.4	Deploy frames	Month 4	Month 22
3.5	Inventory birds and bats	Month 4	Month 22
3.6	Store and ship water samples	Month 4	Month 22
3.7	Deliver known fecal samples	Month 4	Month 22
4	**Data Management and Reporting**		
4.1	Data reviews & transfers	Month 4	Month 23
4.2	Develop final report	Month 19	Month 23
4.3	Present findings at meetings	Month 19	Month 23

[1] Month 1 = September 2011
[2] Month 24 = July 2013

A7 Quality Objectives and Criteria

The objective of this section is to ensure that data collected meet the DQOs of the project. The major objective is to develop and implement an experimental study design providing for the collection of environmental data to test the hypothesis that bridges containing significant numbers of roosting and nesting birds and bats increase ambient bacteria concentrations of streams under low flow conditions as compared to the situation where roosting and nesting are absent. A secondary objective is to supplement the Texas *E. coli* BST Library with known fecal samples from the study area. At the end of this two-year project, desired outcomes include: 1) selection of appropriate bridge crossings of streams for the study, and 2) collection of adequate data to allow statistical evaluation of a test hypothesis regarding instream bacteria influences from bird and bat habitation of bridges.

Surface Water Quality Monitoring

The effects of significant populations of birds or bats nesting underneath bridges on bacteria concentrations will be assessed through water quality monitoring of three bridge crossings of streams. Measurement performance criteria to support the project objective are specified in Table A7-1.

Based on reconnaissance within the Leon and Lampasas Rivers watersheds, two bridges were selected that host roosting or nesting populations of birds and/or bats and one bridge was selected as a control with either an absence or minimal presence of birds and/or bats. Bridge crossings will be sampled under biased flow conditions (low flow not influenced by stormwater runoff). During survey events, measurements of DO, conductivity, pH, water temperature, and stream flow will be obtained in situ. Field data will be logged on field data sheets and incorporated into a computer-based database maintained by TIAER.

Water samples will be analyzed by the TIAER Laboratory for *E. coli* within designated holding times using methods specified in Tables A7.1 and B2.1. Appropriate DQOs and QA/QC requirements for this analysis are also reported in Tables A7.1 and B2.1. Additionally, TIAER field staff will collect known source fecal samples. The TIAER laboratory will preprocess them for BST analyses and ship them to SCSC as outlined in Sections B1, B2 and B3.

BST Sample Preparation

BST analysis is not directly part of this project. Therefore inclusion of materials on BST will be kept to the amount needed to properly cover the aspects of this project resulting in known source and unknown source samples (Method 1603 modified mTEC plates) being properly prepared and shipped to SCSC.

Table A7.1 Measurement Performance Specifications for Routine Water Quality Monitoring

Parameter	Units	Matrix	Method	Parameter Code	AWRL	Limit of Quantitation	LOQ Ck Std % Recovery	Precision	Bias (LCS % Rec.)	Lab
Field Parameters										
pH	pH/ units	water	EPA 150.1 and TCEQ SOP, V1	00400	NA	NA	NA	NA	NA	Field
DO, dissolved oxygen	mg/L	water	EPA 360.1 and TCEQ SOP, V1	00300	NA	NA	NA	NA	NA	Field
Specific Conductance	µS/cm	water	EPA 120.1 and TCEQ SOP, V1	00094	NA	NA	NA	NA	NA	Field
Temperature	^{o}C	water	EPA 170.1 and TCEQ SOP V1	00010	NA	NA	NA	NA	NA	Field
Flow	cfs	water	TCEQ SOP V1	00061	NA	NA	NA	NA	NA	Field
Days since last precipitation	Days	water	TCEQ SOP V1	72053	NA	NA	NA	NA	NA	Field
Flow severity	1 no flow, 2 low, 3 normal, 4 flood 5 high, 6 dry	water	TCEQ SOP V1	01351	NA	NA	NA	NA	NA	Field
Flow measurement method	1-gage 2-electric 3-mechanical 4-weir/flume 5-doppler	other	TCEQ SOP V1	89835	NA	NA	NA	NA	NA	Field
Conventional Laboratory Parameters										
E. coli mTEC	CFU/100 mL	water	USEPA 1603	31648	1	1	NA	0.5 [1]	NA	TIAER

[1] Based on range statistics described in *Standard Methods for the Examination of Water and Wastewater*, Online Edition, Section 9020-B "QA/QC – Intralaboratory QC Guidelines." This criterion applies to bacteria duplicates with concentrations >20 CFU/100mL.

References:

USEPA *Methods for Chemical Analysis of Water and Wastewater*, Manual # EPA-600/4-79-020.

American Public Health Association, American Water Works Association and Water Environment Federation, *Standard Methods for the Examination of Water and Wastewater*, online Ed.

TCEQ Surface Water Quality Monitoring (SWQM) Procedures, Volume 1: Physical and Chemical Monitoring Methods, latest version (RG-415) and updates issued by TCEQ

Limit of Quantitation (LOQ)

Ambient water reporting limits, or AWRLs, are the specifications at or below which data for a parameter must be reported to be compared with the freshwater screening criteria. The AWRLs specified in Table A7.1 are the program-defined reporting specifications for each analyte and yield data acceptable to meet the project objectives. The LOQ is the minimum level concentration, or quantity of a target variable (e.g., target analyte) that can be reported with a specified degree of confidence. The AWRL and LOQ for target analytes and performance limits for LOQs are set forth in Table A7.1

The laboratory's LOQ must be at or below the AWRL as a matter of routine practice.

Acceptance criteria are defined in Section B5.

Precision

Precision is the degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves. It is a measure of agreement among replicate measurements of the same property, under prescribed similar conditions, and is an indication of random error.

For bacteria analysis, laboratory precision is assessed by comparing replicate analyses of sample/duplicate pairs. Precision results are compared against measurement performance specifications and used during evaluation of analytical performance. Program-defined measurement performance specifications for precision are defined in Table A7.1.

Bias

Bias is a statistical measurement of correctness and includes multiple components of systematic error. A measurement is considered unbiased when the value reported does not differ from the true value. Bias is determined through the analysis of laboratory control samples and LOQ Check Standards prepared with verified and known amounts of all target analytes in the sample matrix (e.g., deionized water, sand, commercially available tissue) and by calculating percent recovery. Results are compared against measurement performance specifications and used during evaluation of analytical performance.

Presently, laboratory methods are not required to measure bias for *E. coli* analyses.

Representativeness

Representativeness is a measure of how accurately a monitoring program reflects the actual water quality conditions typical of a waterbody. Site selection, the appropriate sampling regime, the sampling of all pertinent media, and use of only approved analytical methods will ensure that the measurement data represents the conditions at the site. All surveys will be conducted under low-flow conditions not influenced by stormwater runoff. Low-flow conditions were selected as a criterion for survey conditions, because these conditions occur frequently in Texas streams and these conditions maximize the influence of direct fecal deposition on instream conditions as compared to higher flows that afford greater dilution. The goal for meeting total representation of the waterbody will be tempered by the potential funding for complete representativeness.

Completeness

The completeness of the data is basically a relationship of how much of the data is available for use compared to the total potential data. Ideally, 100% of the data should be available. However, the possibility of unavailable data due to accidents, insufficient sample volume, broken or lost samples, etc. is to be expected. Therefore, it will be a general goal of the project that 90% data completion is achieved.

Comparability

Confidence in the comparability of data sets for this project is based on the commitment of project staff to use only approved sampling and analysis methods and QA/QC protocols in accordance with quality system requirements and as described in this QAPP. Comparability is also guaranteed by reporting data in standard units, by using accepted rules for rounding figures, and by reporting data in a standard format as specified in Section B10.

A8 Special Training/Certification

Surface Water Quality Monitoring

Field personnel receive training in proper sampling and field analysis. Before actual sampling or field analysis occurs, they will demonstrate to the QAO (or designee) their ability to properly calibrate and operate field equipment. Field personnel training is documented and retained in the personnel file and will be available during a monitoring systems audit. No special certifications are required.

Preprocessing for BST Analysis

All personnel involved in sample analyses and statistical analyses have received the appropriate education and training required to adequately perform their duties. No special certifications are required. The SCSC will also provide, as necessary, guidance and training to TIAER personnel regarding the preprocessing of BST samples. TIAER is NELAP certified for *E. coli* analysis, used in isolating *E. coli* as part of the preprocessing procedure prior to shipment for BST analysis.

A9 Documents and Records

Surface Water Quality Monitoring
Hard copies of all field data sheets, COC forms, laboratory data entry sheets, calibration logs, and CARs will be archived by TIAER for at least five years after close of the project. In addition, TIAER will archive electronic forms of all project data for at least five years. TIAER field data sheets are in Appendix A and the TIAER COC form is in Appendix B.

Project Documentation
TIAER will electronically produce Quarterly Progress Reports (QPRs) for the TSSWCB combining information from all project partners and will note activities conducted in connection with audits of the water quality monitoring program, items or areas identified as potential problems (e.g., CARs impacting data quality), and any variations or supplements to the QAPP.

CARs will be utilized when necessary (Appendix C). CARs will be maintained in an accessible location for reference at TIAER. CARs that result in any changes or variations from the QAPP will be made known to pertinent project personnel and documented in an update or amendment to the QAPP, when appropriate.

Individuals listed in Section A3 at TIAER and SCSC will be notified of approval of the most current copy of the QAPP by the TIAER PM. The TIAER PM will ensure the distribution of the most recent version of the QAPP to those on the A3 list.

The final project reports will be produced electronically and as a hard copy, and all files used to produce the final report will be saved electronically by TIAER for at least five years.

The documents and records that describe, specify, report, or certify activities are listed in Table A9.1. The TSSWCB may elect to take possession of records at the conclusion of the specified retention period.

As an electronic data protection strategy, TIAER utilizes Double Take software to mirror the Primary Aberdeen 1.2TB file server TIAER5A located in Hydrology 2nd floor (* RAID 5 fault tolerant) that will be mirrored to a secondary Aberdeen Abernas211 file server TIAER5B located in Davis Hall 4th floor (* RAID 5 fault tolerant). This provides instant fault recovery rollover capability in the event of hardware failure. TIAER also exercises complete backup of its Primary server to LTO-3 Quantum ValueLoader on a weekly basis, coupled with daily incremental backups. This provides a third level of fault tolerance in the event that both the primary and secondary servers are disabled. TIAER will maintain all cyclic backup tapes for 26 weeks prior to reuse saving the 1st tape in the series indefinitely to preserve a historical snapshot. This will facilitate recovery of data lost due to human error. Backup tapes are stored in a secure area on the Tarleton State University campus and are checked periodically to ensure viability. If necessary, disaster recovery can also be accomplished by manually re-entering the data.

Table A9.1 Records and Documents Retention Requirements

Document/Record	Location	Retention	Format
QAPPs, amendments and appendices	TIAER QAO Offices	5 years	Paper
QAPP, distribution documentation	TIAER Main Office	5 years	Paper
Field training records	TIAER Field Offices	5 years	Paper
Field notebooks or data sheets	TIAER Field Offices	5 years	Paper
Field equipment calibration/maintenance logs	TIAER Field Offices	5 years	Paper
Field instrument printouts	TIAER Field Offices	5 years	Paper
Field SOPs	TIAER Field Offices	5 years	Paper
Chain of custody records	TIAER Data Management Offices	5 years	Paper
Laboratory Quality Manuals	TIAER Laboratory	5 years	Paper/ electronic
Laboratory SOPs	TIAER Laboratory	5 years	Paper/ electronic
Laboratory training records	TIAER Laboratory	5 years	Paper
Laboratory instrument printouts	TIAER Laboratory or Offsite Storage	5 years	Paper/ electronic
Lab equipment maintenance logs and calibration records	TIAER Laboratory or Offsite Storage	5 years	Paper
Laboratory data reports/results	TIAER calibration records or Offsite Storage	5 years	Paper/ electronic
Corrective Action Documentation	TIAER offices	5 years	Paper/ electronic

Laboratory Documentation

The TIAER laboratory will document sample results clearly and accurately. Information about each water quality sample will include the following to aid in interpretation and validation of data:

- A clear identification of samples analyzed for the project including station information
- Date and time of sample collection
- Identification of preservation and analysis methods used
- Sample results, units of measurement, and sample matrix
- Information on QC failures or deviations from requirements that may affect the quality of results or is necessary for verification and validation of data

Electronic Data

All field, flow, and mTEC *E. coli* data will be submitted to the TSSWCB at least quarterly in the event/result format specified in the TCEQ Data Management Reference Guide (DMRG) for upload to SWQMIS. The Data Summary checklist as contained in Appendix E of this document will be submitted with the data. The survey stream data will be submitted under monitoring type BF. Data collection sites for this project have been or will be assigned a Station Identification Number by TCEQ.

Submitting Entity, Monitoring Entity, and Monitoring Type will reflect the entity reporting the data, the entity collecting the data, and the data collection targeted toward NPS data as follows:

Sample Description	Submitting Entity	Monitoring Entity	Monitoring Type
E. coli, and field and flow data from bridge sites	TSSWCB (TX)	TIAER (TA)	BF

Revisions to the QAPP

Until the work described is completed, this QAPP shall be revised as necessary and reissued annually on the anniversary date of QAPP approval, or revised and reissued within 120 days of significant changes, whichever is sooner. The most recently approved QAPP shall remain in effect until revisions have been fully approved; re-issuances (i.e., annual updates) must be submitted to the TSSWCB for approval before the anniversary date. If the entire QAPP is current, valid, and accurately reflects the project goals and organization's policy, the annual reissuance may be done by a certification that the plan is current. This can be accomplished by submitting a cover letter stating the status of the QAPP and a copy of new, signed approval pages for the QAPP.

Amendments

Amendments to the QAPP may be necessary to reflect changes in project organization, tasks, schedules, objectives, and methods; address deficiencies and non-conformances; improve operational efficiency; and/or accommodate unique or unanticipated circumstances. Requests for amendments are directed from the TIAER PM to the TSSWCB PM in writing. The changes are effective immediately upon approval by the TSSWCB PM and QAO.

Amendments to the QAPP and the reasons for the changes will be documented, and revised pages will be forwarded to all persons on the QAPP distribution list by the TIAER QAO. Amendments shall be reviewed, approved, and incorporated into a revised QAPP during the annual revision process or within 120 days of the initial approval in cases of significant changes.

B1 Sampling Process Design

The project objective is to collect environmental data of sufficient quantity and quality to allow assessment of the effects of bird and bat habitation under bridges on *E. coli* concentrations under low flow conditions.

The basic experimental design consists of intensive monitoring at three selected bridge/stream crossings (stations). Two of the bridges will have seasonal presence of active nesting birds and/or roosting bats (bird stations) and one bridge will be a control with an absence or near absence of birds and bats (control station). A total of 21 survey events will occur over the 2-year monitoring period. During the first period of monitoring (spring and summer 2012) each of the 3 bridge/stream stations will be sampled 4 times (total of 12 of the 21 events). During the second year of monitoring (late 2012 – summer 2013) the control will change from a spatial control to a temporal control defined as sampling one bird station prior to the arrival of birds and bats in late March to early April. One of the two bird stations will be sampled 6 times (3 times before arrival of birds and/or bats and 3 times when birds and/or bats are actively present) and the other bridge will be sampled 3 times when birds and/or bats are present. Cumulatively, this sampling results in 21 total events (12 in 2012 and 9 in 2013).

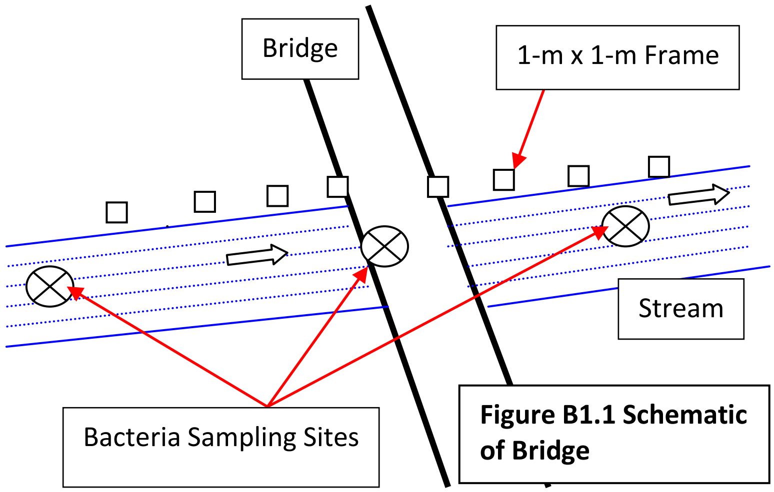


Figure B1.1 Schematic of Bridge

The monitoring at each station will occur at 3 sites during each survey; the first site will be immediately off the upstream edge of the bridge, the second upstream of the bridge, and the third downstream of the bridge (Figure B1.1). Within the physical constraints of stream access and private property fencing, the upstream and downstream sites will be beyond immediate proximity to the bridge, preferably a distance of as much as 50 m from the bridge.

A survey is comprised of the following activities at each bridge/stream crossing:

- three sample collection events (with at least a 30-minute lapse between each event), during which 5 bacteria samples are collected across the stream profile at each of the 3 sampling sites,
- one set of field parameters,
- one flow measurement,
- deployment of the 8 fecal-deposition frames for a 24-hour period

The bacteria sampling with each event will occur such that first 5 samples are collected at the upstream edge of the bridge, followed by 5 samples at the upstream site, and concluding with 5 samples at the downstream site. Each sample will be collected in a manner to avoid disturbance of bottom sediments and spaced by approximately 1 minute for the 5 samples collected at a site. A time lapse of a minimum of 30 minutes will occur between the end of one event and the initiation of the next event. Thus each event will result in the collection of 15 bacteria samples (5 at each of the 3 sites at a station) and the 3 events comprising a survey will result in a total of 45 bacteria samples being collected. All bacteria samples will be iced after collection and returned to the TIAER laboratory within holding time constraints for *E. coli* analysis.

After the bacteria sample collection is completed, streamflow and field parameters (dissolved oxygen, specific conductance, water temperature, and pH) are measured. Flow measurements will be made following the guidelines outlined in the TCEQ SWQM Procedures *Volume 1: Physical and Chemical Monitoring Methods (RG-415)* and manufacturer's instructions.

As the last part of a survey at a station, TIAER staff will deploy frames for measuring direct fecal matter deposition and directly quantify the deposition by counting bird and/or bat droppings in coordination. Frames will be 1 meter by 1 meter squares, unless it is determined that a different size would be more appropriate for certain stations. At each station 4 frames will be deployed upstream of the bridge and 4 downstream with the frames as near the stream as bank slope and other conditions allow (Figure B1.1). For both the upstream and downstream deployments the 4 frames will be deployed 1) immediately below active nests/roosting bats or directly under the outer edge of the bridge for the control station (distance of 0 m), 2) between 2 – 4 m from the outer edge of the bridge, 3) between 5 – 10 m from the bridge, and 4) between 10 – 30 m from the bridge. Distances of the frames from the bridge will be determined by unique conditions at each bridge/stream site, including height of bridge, width of stream, width of right-of-way, and landowner permission to cross fences. Frames will be deployed the day of the bacteria sample collection and retrieved the next day with a total elapsed time of deployment between 20 and 28 hours.

At each station all 4 upstream frames will be deployed on the same side of the stream, as will all 4 downstream frames. However, depending on physical conditions (e.g., density of bird nests, streambank access) the upstream set of frames may or may not be on the same side of the stream as the downstream set. The same side of the stream will be used at each location in all subsequent surveys unless changing physical conditions necessitate switching to the other side.

Direct quantification of fecal deposition will occur by counting bird and/or bat droppings. If droppings are too numerous to count, an estimate will be made. Valid counting will occur either directly in the field or after transport of the frames to the TIAER Stephenville offices.

TIAER will also collaborate with the SCSC, through TSSWCB project 10-50 *Support Analytical Infrastructure and Further Development of a Statewide Bacterial Source Tracking Library*, to conduct BST in the study area to assess and identify different sources contributing to bacteria loadings. Within this SCSC project library-independent BST utilizing the *Bacteroidales* PCR genetic test will be combined with limited library-dependent BST utilizing the ERIC-RP combination method. The Texas *E. coli* BST

Library will also be supplemented with known fecal samples from the study area. Direct data collection for the BST and known source samples under the present project covered by this QAPP is outlined below:

- TIAER will store Method 1603 modified mTEC plates, from 90 water samples, at >0°C to ≤6°C for shipment to SCSC. TIAER will coordinate the shipment of these samples with SCSC such that they are received in College Station within 3 days following enumeration. Stored samples may be used by SCSC to conduct library-dependent BST and analyze *E. coli* isolates utilizing ERIC-PCR and/or RiboPrinting methods. These 90 water samples represent a subset of the 945 samples water samples to be collected during the study.

- The Texas *E. coli* BST Library needs to be supplemented with known fecal samples from the study area. TIAER will deliver to SCSC up to 20 known source fecal samples from birds and/or bats collected for possible addition to the BST library. Fecal samples will be stored at >0°C to ≤6°C and shipped to SCSC.

The collection of BST and known source samples will be spread throughout the project, although an effort will be made to collect more samples early on in the project (particularly the known source samples) to avoid the risk of getting near the end of the project and not having sufficient samples due to unexpected obstacles.

Monitoring at all sampling stations will include *E. coli* enumeration on collected samples within the holding time constraint identified in Table B2.1. The number of bacteria samples planned for collection through this subtask is 945; the number of field and flow samples planned for collection through this subtask is 21. Field parameters are pH, temperature, specific conductance, and dissolved oxygen. Flow parameters are flow measurements collected by gage, electric, mechanical or Doppler. In addition, estimated flow severity and days since last significant precipitation are documented for each crossing (see Table A7.1). Bacteria data are *E. coli* enumerated using USEPA Method 1603.

TIAER will submit Station Location Requests (SLOCs) as needed to obtain TCEQ station numbers for new monitoring sites. TIAER will input the monitoring regime, as detailed in the QAPP, into the TCEQ Coordinated Monitoring Schedule (CMS). TIAER will review and transfer appropriate monitoring data to TSSWCB for inclusion in the TCEQ SWQMIS on at least a quarterly basis. TIAER will be responsible for one final technical report under this task, comprised of the study design, all environmental data, statistical methods, findings, discussion, and conclusions.

Based on reconnaissance trips and landowner permissions to access adjacent land to the bridges, the stations in Figure B1.2 and Table B1.1 will be used. Monitoring frequency is also provided in Table B1.1. Because of the high variability in base flows that can be experienced from year to year and even within a season of sampling, primary stations for sampling are provided as well as secondary stations. Based on hydrologic conditions occurring in Spring 2012, the primary stations are the preferred locations for monitoring. However, should hydrologic conditions change over the course of the study making any of the primary stations unsuitable, e.g., streamflow becomes too low, then a secondary station will be considered to replace the unsuitable primary station. Within the primary and secondary stations of Figure B1.2 and Table B1.1, treatment stations are those with bridges having active nesting birds and/or roosting bats and control stations have an absence or near absence of birds and bats. The TSSWCB Project Manager will be notified before a change is made from a primary station to a secondary station and a QAPP amendment will submitted to TSSWCB.

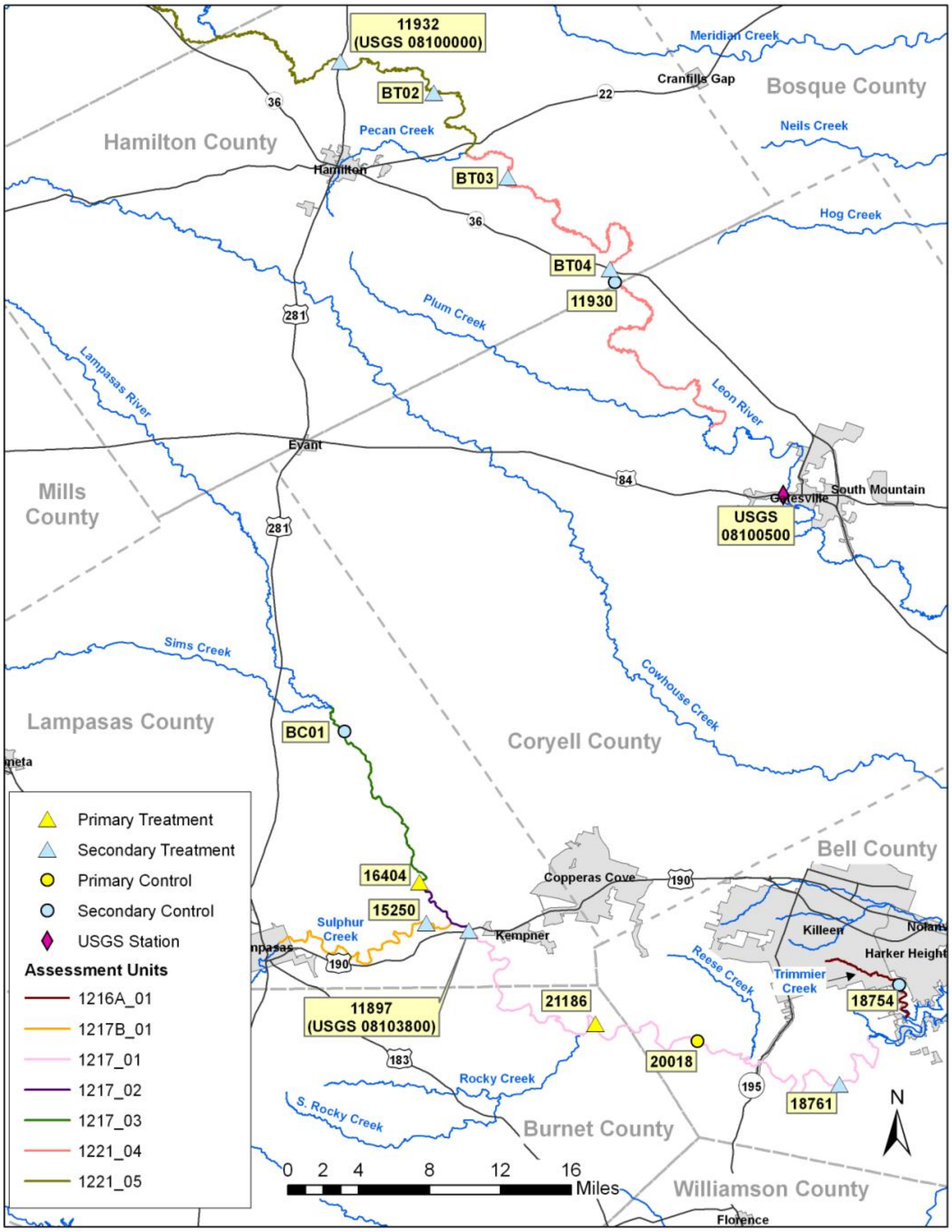


Figure B1.2 Primary and secondary bridge stations and USGS streamflow gages in the watersheds of the Leon River (Segment 1221) and Lampasas River (Segment 1217).

Table B1.1 Monitoring Bridges and Monitoring Frequencies for Each of a Total of 21 Surveys

Bridge ID[a]	Segment_ AU	Location Description	Latitude	Longitude	Type	Frequency of measurements for each project event: # of Surveys	Field	Flow	*E. coli*	Frames
16404	1217_03	Lampasas River @ FM 2313	31.119006	-98.056498	Birds	10	1	1	45	8
21186	1217_01	Lampasas River @ FM 2657	31.003527	-97.912946	Birds	7	1	1	45	8
20018	1217_01	Lampasas River @ Maxdale Rd.	30.989143	-97.829175	Control	4	1	1	45	8

Secondary bridges to use if primary bridges become inaccessible or undesirable

Bridge ID	Segment_ AU	Location Description	Latitude	Longitude	Type
18761	1217_01	Lampasas River @ FM 2484	30.954021	-97.713926	Birds
15250	1217B_01	Sulpher Creek @ FM 1715	31.085466	-98.05123	Birds
18754	1216A_01	Trimmier Creek @ Chaparral Rd	31.035074	-97.664992	Control
BT02	1221_05	Leon River @ FM 2905	31.763385	-98.044921	Birds
11932[b]	1221_05	Leon River @ US 281	31.788836	-98.12138	Birds
11930	1221_04	Leon River @ CR 431	31.608803	-97.896874	Control
BT03	1221_04	Leon River @ CR 301	31.694443	-97.984282	Birds
BT04	1221_04	Leon River @ SH 36	31.619483	-97.901015	Birds
BC01	1217_03	Lampasas River @ FM 1690	31.241921	-98.117502	Control
11897[c]	1217_02	Lampasas River @ US 190	31.079613	-98.016071	Birds & Bats

[a] Numeric IDs are existing TCEQ sampling stations; alphanumeric IDs are temporary IDs

[b] Collocated with USGS gage 08100001

[c] Collocated with USGS gage 08103800

B2 Sampling Methods

Field Sampling Procedures

Field sampling and measurements will be conducted according to procedures documented in the *TCEQ SWQM Procedures Volume 1: Physical and Chemical Monitoring Methods, (RG-415,)* most recent edition and updates issued by TCEQ.

Field parameters will be measured during all surveys at all three bridge survey stations. Field parameters for temperature, specific conductance, pH, and DO will be obtained using a YSI Model 600XLM multi-parameter sonde. Flow measurements will be conducted using a SonTek FlowTracker or other appropriate equipment or method as dictated by water levels and equipment availability. Flow measurements will be made following the guidelines outlined in the TCEQ SWQM Procedures *Volume 1: Physical and Chemical Monitoring Methods (RG-415)* and manufacturer's instructions. During surveys, field data sheets will be completed for each sampling station, regardless of flow status. The section "Documentation of Field Sampling Activities Data" (below) lists the data to be recorded at each station.

Bacteria samples will be collected directly from the stream into containers as specified in Table B2.1. All samples will be collected at 0.3 meter depth, or at mid-depth if the stream is less than 0.3 meter deep, directly into the sample bottle. Samples will be collected by the technician without entering the stream to avoid disturbing bottom sediments. If necessary a pole arrangement with sample bottle attached on one end will be used to collect the sample, carefully avoiding the near surface layer when filling the bottle. Each of the 5 samples collected at a site (i.e., upstream edge of bridge, downstream of bridge, and upstream of bridge) will be obtained in flowing water, avoiding back eddies, spaced at intervals approximately 1-minute apart. Bacteria samples will be collected in sterile, disposable plastic 290 mL bottles that have been factory autoclaved and sealed and include sodium thiosulfate to neutralize up to 15 mg/L of chlorine residual. Samples for bacteria analysis will be screened in the laboratory for the presence of chlorine residual. Bacteria sample containers are labeled as outlined in Section B3, iced immediately in the field, and transported to the laboratory.

As discussed in Section B1, eight frames will be deployed at each of the three bridges for approximately 24 hours following each bacteria sampling survey. The number of droppings on each frame will be counted, with the data normalized to an exact 24-hour period for use in statistical evaluation for the project.

TIAER field staff will perform an inventory of birds and bats inhabiting each of the three bridge crossings, including species identification and population counts. Because of extreme difficulties in quantifying bat populations, the study will emphasize bridge crossings with colonies of swallows, typically cave or cliff swallows as barn swallows do not generally congregate in sizeable colonies. If the study is forced to include bats, an amendment will be needed to the QAPP to include techniques to estimate bat populations. For this two-year project, an initial bird inventory will be made at the beginning of each of the two sampling seasons at each bridge by counting active nests and using literature values to determine average number of birds (adults and young) per nest. A follow-up inventory will occur toward the end of each sampling season. Additionally, qualitative comments regarding bird activity will be included in the comments associated with each survey. The data from the inventories will be used with other project data for evaluation of each station.

Fecal samples for known source analysis will be obtained in the field from selected 1-m by 1-m frames by TIAER field staff members. Fecal samples will be stored at >0°C to ≤6°C and shipped to SCSC for receipt within three days of collection.

Container types, expected sample volumes, preservation requirements, and holding time requirements for bacteria samples are specified in Table B2.1.

Table B2.1 Sample Storage, Preservation and Handling Requirements

Parameter	Matrix	Container	Field Preservation or Handling	Sample Volume	Holding Time
E. coli, mTEC	Water	Sterile plastic	Sodium thiosulfate added; cool to >0 ºC to ≤6ºC	250 mL	8 hours
Fecal specimens	Feces	Sterile Container	Ice/refrigeration, cool to >0 ºC to ≤6ºC	30 g	5 days
E. coli water isolates from *E. coli* mTEC	Water	Petri dish 50mm x 9mm	Ice/refrigeration, cool to >0 ºC to ≤6ºC	See *E. coli*, mTEC	24 – 48 hrs, then shipped to SCSC

Processes to Prevent Cross Contamination

Procedures in the *TCEQ SWQM Procedures Volume 1* outline the necessary steps to prevent cross-contamination of samples. These include such things as direct collection into sample containers and the use of commercially pre-cleaned sample containers.

Documentation of Field Sampling Activities

The following will be recorded for all survey events at which water quality bacteria samples are collected:

1. Station ID
2. Sampling date
3. Station description
4. Sampling depth
5. Sampling time
6. Sample collector’s name/signature
7. Values for all field parameters
8. Detailed observational data, including:
    a. water appearance
    b. weather
    c. biological activity
    d. unusual odors

   e. pertinent observations related to water quality or stream uses
   f. watershed or instream activities
   g. specific sample information
   h. activity of birds
   i. missing parameters
9. Photographic documentation (as appropriate)

Field sampling activities are documented on the Field Data Sheet as presented in Appendix A. Conditions permitting, photos upstream, downstream, right bank, left bank, and nesting areas on bridge will also be recorded for each site during each survey to document stream conditions.

The following will be recorded for data associated with direct fecal deposition on frames:
1. Station ID
2. Station description/location
3. Frame number (e.g., Upstream, No. 1)
4. Frame location (relative to edge of bridge)
5. Sampling beginning date and time
6. Sampling ending date and time
7. Sample collector's name/signature
8. Photographic documentation (as appropriate)

With regard to fecal samples for known source analysis, the following information will be reported as per Appendix D2: Collection of Fecal Samples for Bacterial Source Tracking, using the Known Source COC sheet in Appendix B:
1. Sampling date
2. Animal species
3. Sample location (e.g., GPS coordinates [preferred] or town, city, and/or county)
4. Sample collector's name/initials
5. Any other pertinent information, e.g. sex of animal or any other easily obtainable information such as prevalent species of bird

Recording Data

For the purposes of this section and subsequent sections, all personnel follow the basic rules for recording information as documented below:
1 Legible writing in indelible, waterproof ink with no modifications, write-overs or cross-outs;
2 Changes should be made by crossing out original entries with a single line, entering the changes, and initialing and dating the corrections.
3 Close-outs on incomplete pages with an initialed and dated diagonal line.

Deficiencies, Nonconformances and Corrective Action Related to Sampling Requirements
Deficiencies are defined as unauthorized deviations from procedures documented in the QAPP. Nonconformances are deficiencies that affect quality and render data unacceptable or indeterminate. Deficiencies related to sampling method requirements include, but are not limited to, such things as sample container, volume, and preservation variations; improper/inadequate storage temperature; holding time exceedances; and sample site adjustments.

For TIAER, deficiencies in field sampling activities are documented in logbooks and field data sheets by field or laboratory staff and reported via CAR to the pertinent field or laboratory manager. The supervisor will forward the CAR to the Project QAO. If the situation requires an immediate decision concerning data quality or quantity, the field or laboratory manager will notify the TIAER PM (or designee) within 24 hours. The TIAER PM (or designee) will notify the TIAER Project QAO of the potential nonconformance. The TIAER Project QAO will record and track the CAR to document the deficiency.

The TIAER Project QAO, in consultation as appropriate with the TIAER PM (and other affected individuals/organizations), will determine if the deficiency constitutes a nonconformance. If it is determined the activity or item in question does not affect data quality and therefore is not a valid nonconformance, the CAR will be completed accordingly and closed. If it is determined that a nonconformance does exist, the TIAER PM in consultation with TIAER Project QAO will determine the disposition of the nonconforming activity or item and necessary corrective action(s); results will be documented by completion of a CAR, which is retained by the TIAER Project QAO.

CARs document: root cause(s), programmatic impact(s), specific corrective action(s) to address the deficiency, action(s) to prevent recurrence, individual(s) responsible for each action, the timetable for completion of each action, and the means by which completion of each corrective action will be documented. The TSSWCB will be notified of excursions that affect data quality with QPRs. In addition, significant conditions (i.e., situations that, if uncorrected, could have a serious effect on safety or validity or integrity of data) will be reported to the TSSWCB immediately.

B3 Sample Handling and Custody

Sample Labeling

Water samples will be labeled on the container with an indelible, waterproof marker. Label information includes:

1. Sample Number, Bottle Letter, Station Number, and Site
2. Date and time of collection

A TIAER COC form will accompany all sets of sample containers.

Known Source fecal samples will include at a minimum the label information provided in Section B2. A Known Source Fecal Sample COC will accompany all sets of fecal samples.

Water Quality Sample Handling

All samples are collected according to TCEQ SWQM procedures. All water samples are iced in the field and submitted to the TIAER laboratory on ice the same day they are collected in the field, adhering to the 8-hour holding time for *E. coli* samples. After samples are received at the laboratory, they are inventoried against the accompanying COC. Any discrepancies are noted at that time, remediated if possible, and the COC is signed for acceptance of custody. Sample numbers are assigned, and samples are checked for preservation (as allowed by the specific analytical procedure). Samples are then filtered or pretreated as necessary and placed in a refrigerated cooler dedicated to sample storage, as required.

The laboratory manager has the responsibility to ensure that all holding times are met (see Tables B2.1). Any problems will be documented with a CAR.

Known Source Fecal Sample Handling

Fecal samples will be placed in a fecal tube and refrigerated or kept on ice prior to shipping to SCSC as per SOP in Appendix D.

BST Sample Handling

All samples used in BST analysis will be collected and prepared by TIAER prior to shipment to SCSC. Preprocessing of BST samples will follow SOPs provided by SCSC for library-dependent samples (Isolation of *E. coli* from Water Samples) as provided in Appendix D. TIAER will periodically ship or arrange to deliver bacterial cultures filters following shipping procedures outlined in Appendix D to SCSC for BST analyses.

TIAER will receive water samples and preprocess them for *E. coli* isolation for library-dependent BST samples. *E. coli* will be isolated from the water samples using USEPA Method 1603 and modified membrane thermotolerant *E. coli* (mTEC) medium. Inoculated plates will be incubated at 35±0.5ºC for 2 hours to resuscitate stressed bacteria, and then incubated at 44.5±0.2ºC for approximately 20 to 24 hours. After pre-processing and enumeration by TIAER lab personnel, the plates will be shipped to SCSC. The *E. coli* plates will be shipped to SCSC in insulated coolers with sufficient ice to maintain about 4ºC.

Sample Tracking

Proper sample handling and custody procedures ensure the custody and integrity of samples beginning at the time of sampling and continuing through transport, sample receipt, preparation, and analysis. A sample is in custody if it is in actual physical possession or in a secured area that is restricted to authorized personnel. The COC form documents possession of samples from the time of collection to receipt in the laboratory. The following information is recorded on the TIAER COC form for water samples (See Appendix B).

1. Date and time of collection
2. Site identification
3. Sample matrix
4. Number of containers
5. Residual chlorine
6. Preservative used
7. Was the sample filtered
8. Analyses required (indicated by test group code)
9. Name of collector
10. Custody transfer signatures and dates and time of transfer

For Known Source fecal samples the following information is recorded on the Known Source COC form (Appendix B):

1. Sampling date
2. Animal species
3. Sample location (e.g., GPS coordinates [preferred] or town, city, and/or county)
4. Sample collector's name/initials
5. Any other pertinent information, e.g. sex of animal or any other easily obtainable information such as prevalent species of bird

Deficiencies, Nonconformances and Corrective Action Related to Sample Handling

Deficiencies related to sample handling are documented in logbooks and field data sheets by field or laboratory staff and reported via CAR to the pertinent field or laboratory manager. At TIAER the appropriate supervisor will forward the CAR to the TIAER Project QAO. If the situation requires an immediate decision concerning data quality or quantity, the field or laboratory manager will notify the TIAER PM (or designee) within 24 hours. The TIAER PM (or designee) will notify the TIAER Project QAO of the potential nonconformance. The TIAER Project QAO will record and track the CAR to document the deficiency.

If a sampling handling deficiency is noted by SCSC for BST samples, the TIAER Lead Scientist shall be notified and a CAR produced. The TIAER Lead Scientist will notify the appropriate field staff member, manager of the TIAER or SCSC Laboratory, and the TIAER Project QAO about the sample handling CAR so it may be recorded and tracked.

The TIAER Project QAO, in consultation as appropriate with the TIAER PM (and other affected individuals/organizations), will determine if the deficiency constitutes a nonconformance. If it is determined the activity or item in question does not affect data quality and therefore is not a valid nonconformance, the CAR will be completed accordingly and closed. If it is determined that a nonconformance does exist, the TIAER PM in consultation with TIAER Project QAO will determine the disposition of the nonconforming activity or item and necessary corrective action(s); results will be documented by completion of a CAR, which is retained by the TIAER Project QAO. The TSSWCB will be notified of excursions that affect data quality with QPRs. In addition, significant conditions (i.e., situations that, if uncorrected, could have a serious effect on safety or validity or integrity of data) will be reported to the TSSWCB immediately.

B4 Analytical Methods

Table B4.1 presents the analytical equipment used for project analyses specified in Table A7.1.

Table B4.1. Laboratory and Field Analytical Methods and Equipment

Parameter	Method	Equipment Used
Laboratory Parameters		
Escherichia coli	EPA 1603	Millipore incubator with battery
Field Parameters		
Dissolved Oxygen	EPA 360.1, TCEQ SOP, V1	YSI Multiprobe
Potential Hydrogen	EPA 150.1, TCEQ SOP, V1	YSI Multiprobe
Specific Conductance	EPA 120.1, TCEQ SOP, V1	YSI Multiprobe
Water Temperature	EPA 170.1, TCEQ SOP, V1	YSI Multiprobe
Instantaneous Flow	TCEQ SWQM	Global Water FlowProbe, Pygmy Flow Meter, Price Flow Meter, SonTek FlowTracker, or RDI- Acoustic Doppler Current Profiler

EPA = Methods for Chemical Analysis of Water and Wastes, March 1983
TCEQ SWQM = Texas Commission on Environmental Quality Surface Water Quality Monitoring Procedures, Volume 1 (RG-415, most recent version)
TIAER's SOP for flow measurements is presented in Appendix F.

Sample disposal is in accordance with TIAER SOP-W-101. Normal turnaround time for *E. coli* analysis is 5 days.

Water Quality Analytical Methods

The analytical methods are listed in Table A7.1. Laboratories collecting data under this QAPP are compliant with the NELAC Standards, where applicable.

Copies of laboratory SOPs are retained by TIAER and are available for review by the TSSWCB. Laboratory SOPs are consistent with EPA requirements as specified in the method.

Standards Traceability

All standards used in the field and laboratory are traceable to certified reference materials. Standards and reagent preparation is fully documented and maintained in a standards log book. Each documentation includes information concerning the standard or reagent identification, starting materials, including concentration, amount used and lot number; date prepared, expiration date and preparer's initials/signature. The bottle is labeled in a way that will trace the standard or reagent back to preparation. Standards or reagents used are documented each day samples are prepared or analyzed.

Deficiencies, Nonconformances and Corrective Action Related to Analytical Methods Performed by TIAER

Deficiencies related to analytical methods are noted by TIAER laboratory staff and reported via CAR to the laboratory manager and then forwarded to the Laboratory QAO. If the situation requires an immediate decision concerning data quality or quantity, the field or laboratory manager will notify the TIAER PM within 24 hours. The TIAER PM will notify the TIAER Project QAO of the potential nonconformance.

The TIAER Project QAO will record and track the CAR to document the deficiency.

The TIAER Project QAO, in consultation as appropriate with the TIAER PM (and other affected individuals/organizations), will determine if the deficiency constitutes a nonconformance. If it is determined the activity or item in question does not affect data quality and therefore is not a valid nonconformance, the CAR will be completed accordingly and closed. If it is determined that a nonconformance does exist, the TIAER PM in consultation with TIAER Project QAO will determine the disposition of the nonconforming activity or item and necessary corrective action(s); results will be documented by completion of a CAR, which is retained by the TIAER Project QAO. The TSSWCB will be notified of excursions that affect data quality with QPRs. In addition, significant conditions (i.e., situations that, if uncorrected, could have a serious effect on safety or validity or integrity of data) will be reported to TSSWCB immediately.

TIAER BST Sample Preparation

The analytical methods utilized in BST sample preparation are described in detail in SCSC SOPs (Appendix D).

E. coli in water samples will be quantified and isolated by TIAER personnel using modified mTEC agar, EPA Method 1603 (USEPA 2006). Known source fecal samples will be isolated by SCSC also using EPA Method 1603. The modified medium contains the chromogen 5-bromo-6-chloro-3-indolyl- β-D-glucuronide (Magenta Gluc), which is catabolized to glucuronic acid (a red/magenta-colored compound) by *E. coli* that produces the enzyme β-D-glucuronidase. This enzyme is the same enzyme tested for using other substrates such as the fluorogenic reaction with MUG observed by ultraviolet light fluorescence.

B5 Quality Control (QC)

QC Requirements and Acceptability Criteria for Conventional Parameters

Table A7.1 lists the required accuracy, precision, and completeness limits for the conventional parameter of interest, *E. coli*. It is the responsibility of the TIAER Lead Scientist (or designee) to verify that the data are representative. All incidents requiring corrective action will be documented through use of CARs. Laboratory audits, sampling site audits, and QA of field sampling methods will be conducted by the TSSWCB QAO (or designee).

Batch
A batch is defined as environmental samples that are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents. A **preparation batch** is composed of up to 20 environmental samples of the same NELAC-defined matrix, meeting the above mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be 24 hours. An **analytical batch** is composed of prepared environmental samples (extract, digestates or concentrates) which are analyzed together as a group. An analytical batch can include prepared samples originating from various environmental matrices and can exceed 20 samples.

Method Specific QC Requirements
QC samples, other than those specified later this section, are run (e.g., sample duplicates, surrogates, internal standards, continuing calibration samples, interference check samples, positive control, negative control, and media blank) as specified in the methods. The requirements for these samples, their acceptance criteria or instructions for establishing criteria, and corrective actions are method-specific. Detailed laboratory QC requirements and corrective action procedures are contained within the individual laboratory QAM. The minimum requirements that all participants abide by are stated below.

Laboratory Duplicates
A laboratory duplicate is prepared by taking aliquots of a sample from the same container under laboratory conditions, which are processed and analyzed independently. Both samples are carried through the entire preparation and analytical process. A bacteriological duplicate is considered to be a special type of laboratory duplicate and applies when bacteriological samples are analyzed. Bacteriological duplicate analyses are performed on samples from the sample bottle on a 10% basis. Results of bacteriological duplicates are evaluated by calculating the logarithm of each result and determining the range of each pair. Measurement performance specifications are used to determine the acceptability of duplicate analyses as specified in Table A7.1. The specifications for bacteriological duplicates in Table A7.1 apply to samples with concentrations > 20 organisms/100mL.

Method blank
A method blank is a sample of matrix similar to the batch of associated samples (when available) that is free from the analytes of interest and is processed simultaneously with and under the same conditions as the samples through all steps of the analytical procedures, and in which no target analytes or interferences

are present at concentrations that impact the analytical results for sample analyses. The method blanks are performed at a rate of once per preparation batch. The method blank is used to document contamination from the analytical process. The analysis of method blanks should yield values less than the LOQ. For very high-level analyses, the blank value should be less than 5% of the lowest value of the batch, or corrective action will be implemented.

Samples associated with a contaminated blank shall be evaluated as to the best corrective action for the samples (e.g. reprocessing or data qualifying codes). In all cases the corrective action must be documented. The method blank shall be analyzed at a minimum of one per preparation batch. In those instances for which no separate preparation method is used (example: volatiles in water), the batch shall be defined as environmental samples that are analyzed together with the same method and personnel, using the same lots of reagents, not to exceed the analysis of 20 environmental samples.

Deficiencies, Nonconformances and Corrective Action Related to QC

Deficiencies noted by TIAER are documented in logbooks and field data sheets by field or laboratory staff and reported via CAR to the pertinent field or laboratory manager. The supervisor will forward the CAR to the Project or Laboratory QAO. If the situation requires an immediate decision concerning data quality or quantity, the field or laboratory manager will notify the TIAER PM within 24 hours. The TIAER PM will notify the TIAER Project QAO of the potential nonconformance. The TIAER Project QAO will record and track the CAR to document the deficiency.

The TIAER Project QAO, in consultation as appropriate with the TIAER PM (and other affected individuals/organizations), will determine if the deficiency constitutes a nonconformance. If it is determined the activity or item in question does not affect data quality and therefore is not a valid nonconformance, the CAR will be completed accordingly and closed. If it is determined that a nonconformance does exist, the TIAER PM, in consultation with the TIAER Project QAO, will determine the disposition of the nonconforming activity or item and necessary corrective action(s); results will be documented by completion of a CAR, which is retained by the TIAER Project QAO. The TSSWCB will be notified of excursions that affect data quality with QPRs. In addition, significant conditions (i.e., situations that, if uncorrected, could have a serious effect on safety or validity or integrity of data) will be reported to TSSWCB immediately.

B6 Instrument/Equipment Testing, Inspection and Maintenance

All equipment inspection and maintenance requirements for project activities will follow manufacturer and annual preventative maintenance guidance for each instrument and equipment item.

Surface Water Quality Monitoring

All sampling equipment testing and maintenance requirements are detailed in the latest version of and updates to *TCEQ Surface Water Quality Monitoring Procedures (Volume 1)* and TIAER's SOP for flow measurement (Appendix F). Sampling equipment is inspected and tested upon receipt and is assured appropriate for use. Equipment records are kept on all field equipment and a supply of critical spare parts is maintained.

All laboratory tools, gauges, instrument, and equipment testing and maintenance requirements are contained within laboratory SOPs.

Records of all tests, inspections, and maintenance will be maintained and log sheets kept showing time, date, and analyst signature. These records will be available for inspection by the TSSWCB.

Failures in any testing, inspections, or calibration of equipment will result in a CAR and resolution of the situation will be reported to the TSSWCB in the QPR. The CARs will be maintained by the TIAER Project QAO.

B7 Instrument/Equipment Calibration and Frequency

Calibration and calibration frequency are performed according to manufacturer and annual preventive maintenance guidance for each instrument and equipment item.

Surface Water Quality Monitoring

Field equipment calibration requirements are contained in the latest version of and updates to the *TCEQ Surface Water Quality Monitoring Procedures* and TIAER's SOP for flow measurement (Appendix F). Post-calibration error limits and the disposition resulting from error are adhered to. Post-calibrations not meeting error limit requirements invalidate associated data collected subsequent to the pre-calibration and are not submitted to the TCEQ. Detailed laboratory calibrations are contained within the TIAER QAM.

B8 Inspection/Acceptance of Supplies and Consumables

Water Quality Analysis

New batches of TIAER supplies are tested and the results recorded in the appropriate logbook before use to verify that they are not contaminated. The TIAER QAM provides additional details on acceptance requirements for laboratory supplies and consumables.

B9 Non-Direct Measurements

TIAER will conduct a literature search for this project. The literature search will include journal articles, technical reports, and other publications that examine the fecal loading rates and instream bacteria influences of birds and bats inhabiting bridges. TIAER will also consult with the Center for Research in Water Resources at the University of Texas at Austin and the Texas Department of Transportation to include publications they may have found.

All other data for the project will be generated during the project according to requirements in this QAPP.

B10 Data Management

Data Path - TIAER

Water quality samples are collected and transferred from the field to the laboratory for analyses as described in Section B3 using a TIAER COC form (Appendix B) following procedures in TIAER SOP-Q-110, Sample Receipt and Log In. A unique sample identification number is given to each sample at log in. Identifying sample information and comments are manually entered into the initial database queue. Laboratory measurement results are entered into a secondary database queue, either automatically or manually, depending on the instrument. Following laboratory data verification and validation, the data are transferred from the secondary queue database to the master queue within the TIAER LIMS. At this point, any additional manually generated field data or comments are added to the LIMS database by the field crew and validated by a separate individual. Data from TIAER's LIMS are then uploaded to a SAS software database, which is used for statistical evaluation of the data to evaluate project objectives. Procedures and personnel involved in data entry and review are outlined in TIAER SOP-Q-104, Data Entry and Review.

Field parameters collected with the YSI multiprobe (pH, water temperature, conductivity, and dissolved oxygen) are automatically downloaded from the instrument and imported into an EXCEL spreadsheet. Printouts of the sonde data are compared with manually entered data on the field data sheets for validation. The electronic sonde data are then exported to a SAS database and automatically merged with the SAS database containing the LIMS data by site, date, and time and again reviewed by field crew personnel to make sure the data merge occurred correctly.

Flow data collected during survey events will be stored in a SAS or WISKI database for review. Records of site visits are kept on the GM sheets (Appendix A). Flow data are reviewed in WISKI by appropriate field staff and then transferred back to SAS for storage.

Following data verification and validation, data appropriate for SWQMIS are exported from the database to pipe-delimited text files in TCEQ format for reporting to the TSSWCB. Upon completion of a data review, TSSWCB will submit these files, as appropriate, to TCEQ for entry into SWQMIS. .

Record-Keeping and Data Storage

TIAER record-keeping and document control procedures are contained in the TIAER QAM and this QAPP. Original field and laboratory data sheets are stored in the TIAER offices, laboratory, and storage facility in accordance with the record-retention schedule in Section A9. As an electronic data protection strategy, TIAER utilizes Double Take software to mirror the Primary Aberdeen 1.2TB file server (raid 5 fault tolerant) that will be mirrored to a secondary Aberdeen Abernas211 file server (raid 5 fault tolerant). This provides instant fault recovery rollover capability in the event of hardware failure. TIAER also exercises complete backup of its Primary server to LTO 3 Quantum ValueLoader on a weekly basis, coupled with daily incremental backups. This provides a third level of fault tolerance in the event that both the primary and secondary servers are disabled. TIAER will maintain all cyclic back-up tapes for 26 weeks prior to reuse saving the 1st tape in the series indefinitely to preserve an historical snapshot. This will facilitate recovery of data lost due to human error. Backup tapes are stored in a secure area on the Tarleton State University campus and are checked periodically to ensure viability. If necessary, disaster recovery can also be accomplished by manually re-entering the data.

Data Verification/Validation

The control mechanisms for detecting and correcting errors and for preventing loss of data during data reduction, data reporting, and data entry are contained in Sections D1, D2, and D3.

TIAER laboratory technicians review all data before finalizing data. The Laboratory Manager reviews all data following analysis and checks for calculation errors or data entry errors. The TIAER LQAO performs a third review of data to determine validity within this QAPP.

Data that are not valid, for quality reasons, will not be submitted to the TSSWCB. This determination will be made by the TIAER Lead Scientist/Project QAO in coordination with the TSSWCB PM and QAO.

Forms and Checklists

See Appendix A for the Field Data Sheets and Appendix E for the Data Summary Checklist.

Data Handling, Hardware, and Software Requirements

For data handling, TIAER utilizes standard, IBM compatible, desktop personal computers that utilize a MS Windows operating system. TIAER utilizes MS Access 2007 as the primary database management software. TIAER's Water Quality Database has been developed according to CRP guidance and database structures in accordance with TSSWCB and TCEQ requirements. Hardware configurations are sufficient to run Microsoft Access and SAS software in a networked environment. Specific hardware is also configured to run WISKI and FLOWLINK software, but not necessarily in a networked environment for continuous stage data. TIAER information resources staff is responsible for assuring that hardware configurations meet the requirements for running current and future data management/database software as well as providing technical support.

C1 Assessments and Response Actions

The following table presents types of assessments and response actions for data collection and analysis activities applicable to the QAPP and all facets of the project.

Table C1.1 Assessments and Response Requirements

Assessment Activity	Approximate Schedule	Responsible Party	Scope	Response Requirements
Status Monitoring Oversight, etc.	Continuous	TIAER PMs	Monitor project status and records to ensure requirements are being fulfilled.	Report to TSSWCB in QPRs
Laboratory Inspection	At least once during the project period.	TSSWCB	Analytical and QC procedures employed at the laboratories	45 days to respond in writing to TSSWCB to address corrective actions
Technical Systems Audit	At least once during the project period.	TSSWCB	Assess compliance with QAPP; review facility and data management as they relate to the project	45 days to respond in writing to TSSWCB to address corrective actions
Monitoring Systems Audit	At least once during the project period.	TSSWCB	Assess compliance with QAPP; review field sampling, facility and data management as they relate to the project	45 days to respond in writing to TSSWCB to address corrective actions

In-house review of data quality and staff performance to assure that work is being performed according to standards will be conducted by all entities. If review shows that the work is not being performed according to standards, immediate corrective action will be implemented. CARs will be submitted to TSSWCB and documented in the project QPRs.

The TSSWCB QAO (or designee) may conduct an audit of the field or technical systems activities for this project no less than once over the contractual period of the project. Each entity will have the responsibility for initiating and implementing response actions associated with findings identified during the on-site audit. Once the response actions have been implemented, the TSSWCB QAO (or designee) may perform a follow-up audit to verify and document that the response actions were implemented effectively. Records of audit findings and corrective actions are maintained by the TSSWCB PM and TIAER Project QAO. Corrective action documentation will be submitted to the TSSWCB PM with the progress report. If audit findings and corrective actions cannot be resolved, then the authority and responsibility for terminating work is specified in agreements or contracts between participating organizations.

Corrective Action Process for Deficiencies

Deficiencies are any deviation from the QAPP, *TCEQ SWQM Procedures*, TIAER or SCSC SOPs. Deficiencies may invalidate resulting data and may require corrective action. Corrective action may include for samples to be discarded and recollected. Deficiencies are documented in logbooks, field data sheets, etc. by field or laboratory staff. It is the responsibility of each respective entity's PM and/or Lead Scientist, in consultation with the TIAER Project QAO, to ensure that the actions and resolutions to the problems are documented and records are maintained in accordance with this QAPP. In addition, these actions and resolutions will be conveyed to the TSSWCB PM both verbally and in writing in the QPRs and by completion of a CAR. All deficiencies identified by each entity will trigger a corrective action plan.

Corrective Action

Corrective Action Reports (CARs) should:

- Identify the problem, nonconformity, or undesirable situation
- Identify immediate remedial actions if possible
- Identify the underlying cause(s) of the problem
- Identify whether the problem is likely to recur, or occur in other areas
- Evaluate the need for Corrective Action
- Use problem-solving techniques to verify causes, determine solutions, develop an action plan
- Identify personnel responsible for action
- Establish timelines and provide a schedule
- Document the corrective action

The status of CARs will be included with QPRs. In addition, significant conditions (i.e., situations which, if uncorrected, could have a serious effect on safety or on the validity or integrity of data) will be reported to the TSSWCB immediately. The PM, Lead Scientist, or Project Lead of each respective entity is responsible for implementing and tracking corrective actions. Records of audit findings and corrective actions are maintained by the Project Lead or PM of each respective entity. Audit reports and corrective action documentation will be submitted to the TSSWCB with the QPRs.

C2 Reports to Management

Reports to TSSWCB Project Management

All reports detailed in this section are contract deliverables and are transferred to the TSSWCB in accordance with contract requirements.

QPRs – Summarize project activities for each task; reports problems, delays, audit reports, and corrective actions; and outlines the status of each task's deliverables.

Task 4 Final Report – TIAER will develop a Final Report that will discuss the literature search, study design, all environmental data collected, statistical methods, findings, discussion, and conclusions. A draft of this report will be submitted to the TSSWCB for review prior to finalizing the report.

D1 Data Review, Verification, and Validation

For the purposes of this document, data verification is a systematic process for evaluating performance and compliance of a set of data to ascertain its completeness, correctness, and consistency using the methods and criteria defined in the TIAER QAM, TIAER and SCSC SOPs, and this QAPP. Validation means those processes taken independently of the data-generation processes to evaluate the technical usability of the verified data with respect to the planned objectives or intention of the project. Additionally, validation provides a level of overall confidence in the reporting of the data based on the methods used.

All data obtained from field and laboratory measurements will be reviewed and verified for conformance to project requirements, and then validated against the DQOs which are listed in Section A7. Only those data that are supported by appropriate QC data and meet the measurement performance specification defined for this project will be considered acceptable and used in the project.

The procedures for verification and validation of data are described in Section D2. The TIAER Lead Scientist is responsible for ensuring that field data are properly reviewed and verified for integrity. The TIAER Laboratory Supervisor is responsible for ensuring that laboratory data are scientifically valid, defensible, of acceptable precision and bias, and reviewed for integrity. The TIAER Project QAO is responsible for ensuring that all data are properly reviewed and verified, and submitted in the required format to the project database. The TIAER Laboratory QAO is responsible for validating a minimum of 10% of the laboratory data produced in each task. Finally, the TIAER PM, with the concurrence of the TIAER Project QAO, is responsible for validating that all data to be reported meet the objectives of the project and are suitable for reporting to TSSWCB.

D2 Verification and Validation Methods

All field and laboratory data will be reviewed, verified and validated to ensure they conform to project specifications and meet the conditions of end use as described in Section A7 of this document.

Data review, verification, and validation will be performed using self-assessments and peer and management review as appropriate to the project task. The data review tasks to be performed by field and laboratory staff are listed in the first two sections of Table D2.1, respectively. Potential errors are identified by examination of documentation and by manual (or computer-assisted) examination of corollary or unreasonable data. If a question arises or an error is identified, the manager of the task responsible for generating the data is contacted to resolve the issue. Issues which can be corrected are corrected and documented. If an issue cannot be corrected, the task manager consults with higher level project management to establish the appropriate course of action, or the data associated with the issue are rejected. Field and laboratory reviews, verifications, and validations are documented.

After the field and laboratory data are reviewed, another level of review is performed after the data are combined into a data set. This review step as specified in Table D2.1 is performed by the TIAER Data Manager and TIAER Project QAO. Data review, verification, and validation tasks to be performed on the data set include, but are not limited to, the confirmation of laboratory and field data review, evaluation of field QC results, additional evaluation of anomalies and outliers, analysis of sampling and analytical gaps, and confirmation that all parameters and sampling sites are included in the QAPP.

Another element of the data validation process is consideration of any findings identified during the monitoring systems audit conducted by the TSSWCB QAO. Any issues requiring corrective action must be addressed, and the potential impact of these issues on previously collected data will be assessed. After the data are reviewed and documented, the TIAER Lead Scientist validates that the data meet the DQOs of the project and are suitable for reporting to TSSWCB.

If any requirements or specifications are not met, based on any part of the data review, the responsible party should document the nonconforming activities and submit the information to the TIAER Data Manager with the data. This information is communicated to the TSSWCB by TIAER in the Data Summary.

Table D2.1: Data Review Tasks

Staff: PM – Project Manager; QAO – Quality Assurance Officer

Field Data Review	Responsibility
Field data reviewed for conformance with data collection, sample handling and COC, analytical and QC requirements	TIAER Field Supervisor
Post-calibrations checked to ensure compliance with error limits	TIAER Field Supervisor
Field data calculated, reduced, and transcribed correctly	TIAER Field Supervisor
Laboratory Data Review	**Responsibility**
Laboratory data reviewed for conformance with data collection, sample handling and COC, analytical and QC requirements to include documentation, holding times, sample receipt, sample preparation, sample analysis, project and program QC results, and reporting	TIAER Laboratory Manager and QAO
Laboratory data calculated, reduced, and transcribed correctly	TIAER Laboratory Manager and QAO
Analytical data documentation evaluated for consistency, reasonableness and/or improper practices	TIAER Laboratory Manager and QAO
Analytical QC information evaluated to determine impact on individual analyses	TIAER Laboratory Manager and QAO
All laboratory samples analyzed for all parameters	TIAER Laboratory Manager and QAO
Data Set Review	**Responsibility**
The test report has all required information as described in Section A9 of the QAPP	TIAER QAO and Lead Scientist
Confirmation that field and laboratory data have been reviewed	TIAER QAO and Lead Scientist
Data set (to include field and laboratory data) evaluated for reasonableness and if corollary data agree	TIAER QAO and Lead Scientist
Outliers confirmed and documented	TIAER QAO and Lead Scientist
Field QC acceptable (e.g., field splits and trip, field and equipment blanks)	TIAER QAO and Lead Scientist
Sampling and analytical data gaps checked and documented	TIAER QAO and Lead Scientist
Verification and validation confirmed. Data meets conditions of end use and are reportable	TIAER QAO and Lead Scientist

D3 Reconciliation with User Requirements

Data produced in this project, and data collected by other organizations (e.g., USGS, TCEQ, etc.), will be analyzed and reconciled with project data quality requirements. Data meeting project requirements will be used by TSSWCB and other project partners to assess sources of bacteria through data analysis and modeling and to ascertain the suitability of the streams for contact recreation use in order to facilitate local decision-making. Additionally, data meeting project requirements will be submitted by the TSSWCB to the TCEQ for use in the biennial CWA §305(b) assessment for the *Texas Integrated Report*. Data that do not meet requirements will not be submitted to SWQMIS nor will it be considered appropriate for any of the uses noted above.

Appendix A

Field Data Sheets

E. coli & Field Observations - Bird Bridge Bacteria Project

Draft Copy (02 November 2012)

Date Project **BBBB** Code	Stream Segment **1217** Station ID	Survey No. Event No.
Investigators	**Observations (Use Codes Below)** Flow severity Wind Intensity Present Weather DSLP	

Flow severity 1. no flow 2. low 3. normal 5. high 4. flood 6. dry
Flow method 1. gage 2. electric 3. mechanical 4. weir/flume 5. doppler
Wind intensity 1. Calm 2. Slight 3. Moderate 4. Strong
Present Weather 1. Clear 2. Pt. Cloudy 3. Cloudy 4. Rain
Days Since Last Precip. (in days) <1 (within 24 h) 1 2 3 4 5 6 7 >7 (over a week)

Sonde and flow data to be entered into ESDMS with sample B5 of Event 3

Measured Flow (cfs): Flow Method:

Sonde	Display	Sample Depth (m)	Total Depth (m)	Sample Time	Temp °C	Cond µs	DO mg/L	pH

Bacteria Sample Information

Upstream Bridge Face						
Sample	Collector	Sample Depth (m)	Total Depth (m)	Sample Time	Distance From Bank	Comments
1						
2						
3						
4						
5						
Upstream						
Sample	Collector	Sample Depth (m)	Total Depth (m)	Sample Time	Distance From Bank	Comments
1						
2						
3						
4						
5						
Downstream						
Sample	Collector	Sample Depth (m)	Total Depth (m)	Sample Time	Distance From Bank	Comments
1						
2						
3						
4						
5						

General Observations

Photographs

Fecal Counts - Bird Bridge Bacteria Project

Draft Copy (02 November 2012)

Project: **BBBB** Stream Segment: **1217**	Station ID:		Survey No.:
Start date/time:	End date/time:		
Weather Observations (Use Codes Below, do not circle)			
AT DEPLOYMENT		*AT RETRIEVAL*	
Flow Sev.	Wind Intensity	Flow Sev.	Wind Intensity
Present Weather	DSLP	Present Weather	DSLP

Flow severity: 1. no flow 2. low 3. normal 5. high 4. flood 6. dry
Wind intensity: 1. Calm 2. Slight 3. Moderate 4. Strong
Present Weather: 1. Clear 2. Pt. Cloudy 3. Cloudy 4. Rain
Last Significant Rainfall (in days): <1 (within 24 h) 1 2 3 4 5 6 7 >7 (over a week)

Fecal Count Information

Frame	Location	Initials	Tally	Count	Photos (Y/N)
Downstream					
1					
2					
3					
4					
Upstream					
Frame	Location	Initials	Tally	Count	Photos (Y/N)
5					
6					
7					
8					

Station Description
General Observations
Photographs

Appendix B
Chain of Custody Forms for TIAER and Known Source Fecal Samples

TiAER **Chain of Custody / Sample Information Form** Page __ of __ Field data or attachments? (Y/N)

Client or Project Manager	Client phone:	Sampler(s) and Delivery information	0-6°C temp. Therm. used: T-

TIAER Project Code	*TIAER* Lab Sample Number	*TIAER* Test Group Code	Sample Date(s) (mm/dd/yy)	Sample Time(s) (hh:mm) CST for TIAER	*Client* Sample or Site ID	Sample Type	Matrix	Preservative	Preservative and Container types/ number	Comments (if applicable): Flow Weighted data start/end date/time:	bottle numbers:	Other notes (special turnaround times requested may incur premium charges):	Composite only - last bottle collection date/time:	pH <2 check	temp check	Disposed

Relinquished by:	Date/Time: CST DST	Received by:	Date/Time: CST DST
Relinquished by:	Date/Time: CST DST	Received by:	Date/Time: CST DST

Sample Types: G =Grab, SG =Storm Grab, S =Sequential, T =Time based comp., F =Flow based comp., M =Multisonde, O =other | **Matrix:** L=Liquid (nonpotable water), S =Solid or chemical | Form review initials/ date

plastic, F=filter, G=glass **ua/uf**, H=dark glass **uf**, J=glass acidified **uf**, O=other (describe), S=sterile plastic **ua/uf**, V=VOA vial **uf**, W= plastic bag **ua/uf**. I=Ice, HS=Sulfuric acid, HN=Nitric acid

Data entry:

Field review:

Each preservative/container code represents one container ID. If more than one container is submitted for a code, enter the number of each beside the code.

Texas Institute for Applied Environmental Research
Box T-0410, Stephenville, TX 76402, Tarleton State University 254-968-9570, 968-9560

Lab review:

Q-110-1, rev. 7 mm 11/8/10

Sample Acceptance Policy: TIAER retains the right to refuse acceptance of any sample and return any and all portions of samples to the client. Samples submitted with little holding time remaining may not be analyzed in time to meet project requirements. Samples should have at least 50% of holding time remaining when submitted. Unless otherwise agreed upon in writing, Client should submit samples collected and preserved in accordance with 40 CFR 136, the 2003 NELAC Standard, or other regulatory requirement stated by the Client's project. TIAER Lab shall not be responsible for data accuracy on samples improperly collected, preserved or submitted. Samples not appropriately collected, preserved or submitted may be accepted and analyzed by the TIAER Lab at the request of the Client. Unless previously arranged, normal sample acceptance hours without premium fees are Monday-Friday, 0800-1500, exclusive of official Tarleton holidays. Samples submitted outside of the normal hours may be processed at a premium surcharge. By signing to relinquish the sample(s) above, the Client or Client's representative hereby agrees to this policy & conforms to Contract or Cooperative Agreement between Client and TIAER.

CHAIN OF CUSTODY FOR KNOWN-SOURCE FECAL SAMPLES

Project Manager/Person(s) Requesting Sample					Sampler(s)		
Project Code	Sample No.	Test Group Code	Sample Date(s) (mm/dd/yy)	Sample Time(s) (hh:mm) CST for TIAER	Collection Site (GPS coord or town/city/county)	Animal Species	Other comments*

*If available, include other information such as:

1) Further description of animal – sex, age, species, etc.
2) For domesticated animals, further description of operation
   A. Beef v. dairy; if beef, cow-calf v. feedlot; if dairy, was sample collected from fresh manure, lagoon, etc.?
   B. For poultry, name of integrator, age of birds, etc.
3) For WWTP, type of system and treatment stage in plant where sample was collected

Shipment of fecal samples from TIAER to SCSC			
Relinquished by:		Received by:	
Person	Date/Time	Person	Date/Time

Appendix C
Corrective Action Report Form

Corrective Action Report
SOP-Q-105
CAR #: 08-003

Report Initiation Date ________ **Report By:** ____________________ **Procedure or QC Typ** ____________________

Deviation: ____

Analyte: ____

Affected Sample #s: ____

Sampling Station: ____

Project(s): ____

Attached Documentation:
- ☐ COC
- ☐ FDS
- ☐ FlowLink
- ☐ Flow8
- ☐ GM
- ☐ Log Book
- ☐ QC Sheet
- ☐ Memo
- ☐ Other

Details of the problem, nonconformance or out-of-control situation:
____

Possible Causes:
____

Corrective Actions Taken:
____

Corrective Actions Suggested:
____

CAR routed to: ____________________ **Date:** ____________

Supervisor: ○ **Tier 1** (does not affect final data integrity) ○ **Tier 2** (data accepted but flag required) ○ **Tier 3** (possibly affects final data integrity)

Corrective actions taken for specific incident: ____________________

Corrective actions taken to prevent recurrences: ____________________

Corrective actions to be taken: ____________________

Responsible Party: ____________________ **Proposed completion date:** ____________________

Effect on data quality: ____________________

Responsible Supervisor: ____________________ **Date:** ____________

Concurrence:

Program/Project Manager: ____________________ **Date:** ____________
(Tier 3 CARs only)

Quality Assurance Officer: ____________________ **Date:** ____________

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Appendix D

SCSC SOPs for Sample Handling and Shipping of BST and Known Source Samples

- D1: Isolation of *E. coli* from Water Samples: Preprocessing of Water Samples
- D2: Collection of Fecal Samples for Bacterial Source Tracking

D1: Isolation of *E. coli* from Water Samples
Preprocessing of Water Samples

1. Follow the EPA Method 1603 Modified mTEC procedure (EPA-821-R-06-011, Modified EPA Method 1603; http://water.epa.gov/scitech/swguidance/methods/bioindicators/upload/2008_11_25_methods_method_biological_1603.pdf).
2. After 22 +/- 2 hour incubation, red or magenta colonies are considered 'typical' *E. coli*.
3. Colonies counted should be indicated with a 'dot' on the back of the plate to ensure isolation of *E. coli* grown during the incubation period. Total number of counts should also be included on the back of each plate.
4. After counting, the plates should be immediately stored at 4°C until shipment in order to prevent growth of non-*E. coli* coliforms on the plates.
5. In preparation for shipping, each plate should be sealed with parafilm around the edge to protect the filters from contamination. Dilution series for each sample should subsequently be grouped together either by parafilm or zip-top bag for transport.
6. The plates should be shipped as soon as possible (preferably the day after filtration, but no later than three days following filtration) to SAML (address below) at 4ºC. 'Blue-ice' or freezer blocks should be used to keep the samples cool, but not frozen in transport. Samples should be placed in secondary containment such as large Whirl-Pak or zip-top bags.
7. If sampling occurs over two days, the first day's plates should be counted 24 hours post filtration, sealed and placed 'media-side up' (i.e. upside down), so condensation does not fall onto the filter, and stored at 4ºC until a complete sample set can be shipped together on the next day.
8. Notification of shipment should be sent to SAML (Emily Martin and Heidi Mjelde) via email, emartin@ag.tamu.edu and hmjelde@ag.tamu.edu, or phone, SAML Lab 979-845-5604, no later than the day of overnight shipping. Notification should include *E. coli* count datasheet, tracking number, and direct TIAER contact person for confirmation upon receipt of samples.
9. Ship plates (and COCs) in insulated coolers with sufficient ice packs to maintain ~4°C to:

   Terry Gentry
   Texas A&M University
   Soil & Crop Sciences; Heep Center 539
   370 Olsen Blvd
   College Station, TX 77843
   979-845-5604

D2: Collection of Fecal Samples for Bacterial Source Tracking

1. Only fresh fecal samples of known origin should be collected. Specifically, fecal samples should be obtained in one of four ways:
    a. Collected from intestines of animals legally harvested.
    b. Collected from animals visually observed defecating by technician.
    c. Collected from the intestines of animals recently killed by cars (within 24 hours).
    d. Human (wastewater) samples collected from septic tanks or from influent (pre-secondary treatment) at wastewater treatment plants. Alternatively, fecal samples can be collected from individual people.
2. Samples should be carefully collected to avoid contamination. Samples on the ground should be collected with a sterile spatula, or similar device, while avoiding collection of material in contact with soil or other possible sources of contamination. Intestinal samples should be collected from animals by using sterile loops inserted anally or by cutting into the intestine using a sterile scalpel. Wastewater samples can initially be collected with sterile bottles, or other suitable device and then transferred to the fecal tubes described below.
3. Each fecal sample should be placed in a new, sterile fecal tube (Sarstedt, cat# 80.734.311). Tubes should be filled approximately ¾ full (can provide less material for smaller animals).
4. Samples should be refrigerated (~4°C) or kept on ice following collection.
5. At the time of sampling, record detailed information regarding the sample including:
    a. Sampling date
    b. Animal species
    c. Sample location (e.g., GPS coordinates [preferred] or town, city, and/or county)
    d. Sample collector's name/initials
    e. Any other pertinent information, e.g. sex of animal or any other easily obtainable information such as beef cattle versus dairy cattle
6. Notify SAML (Emily Martin and Heidi Mjelde) via email (emartin@ag.tamu.edu and hmjelde@ag.tamu.edu) or phone (SAML Lab 979-845-5604) as soon as possible (prior to or immediately following sample collection) with an estimated number of samples that will be shipped and the expected date of shipment. This will allow SAML to make appropriate preparations to process the samples immediately upon arrival.
7. Samples should be shipped (at 4ºC) as soon as possible (within 5 days) to SAML (address below). 'Blue-ice' or freezer blocks should be used to keep the samples cool, but not frozen during transport. Samples should be placed in secondary containment such as large Whirl-Pak or zip-top bags.
8. Notification of shipment should be sent to SAML (Emily Martin and Heidi Mjelde) via email (emartin@ag.tamu.edu and hmjelde@ag.tamu.edu) or phone (SAML Lab 979-845-5604) no later than the day of overnight shipping. Notification should include tracking number and direct TIAER contact person for confirmation upon receipt of samples.

9. Ship samples (and COCs) in insulated coolers (marked on outside to indicate that contents are perishable) with sufficient ice packs to maintain ~4°C to:

   Terry Gentry
   Texas A&M University
   Soil & Crop Sciences; Heep Center 539
   370 Olsen Blvd
   College Station, TX 77843
   979-845-5604

Appendix E

Data Review and Summary Checklist

DATA SUMMARY CHECKLIST

A completed checklist must accompany all data sets submitted to the TSSWCB by TIAER.

Data Format and Structure Y,N, or N/A
A. Are there any duplicate Tag_Ids in the Events file?
B. Are all StationIds associated with assigned station location numbers?
C. Are all dates in the correct format, MM/DD/YYYY?
D. Are all times based on the 24 hour clock format, HH:MM?
E. Is the Comment field filled in where appropriate (e.g. unusual occurrence, sampling problems)?
F. Are Source1, Source2 and Program codes used correctly?
G. Do the Enddates in the Results file match those in the Events file for each Tag_Id?
H. Are all measurements represented by a valid parameter code with the correct units? I.. Are there any duplicate parameter codes for the same Tag_Id?
J. Are there any invalid symbols in the Greater Than/Less Than (GT/LT) field?
K. Are there any tag numbers in the Result file that are not in the Event file?
L. Have verified outliers been identified with a "1" in the Remark field?

Data Quality Review
A. Are all the "less-than" values reported at or below the specified reporting limit?
B. Have checks on correctness of analysis or data reasonableness performed?
C. Have at least 10% of the data in the data set been reviewed against the field and laboratory data sheets?
D. Are all parameter codes in the data set listed in the QAPP?
E. Are all StationIds in the data set listed in the QAPP?

Documentation Review
A. Are blank results acceptable as specified in the QAPP?
B. Was documentation of any unusual occurrences that may affect water quality included in the Event table's Comments field?
C. Were there any failures in sampling methods and/or deviations from sample design requirements that resulted in unreportable data? If yes, explain on next page.
D. Were there any failures in field and laboratory measurement systems that were not resolvable and resulted in unreportable data? If yes, explain on next page.
E. Was the laboratory's NELAC accreditation current for analyses conducted?

Describe any data reporting inconsistencies with performance specifications. Explain failures in sampling methods and field and laboratory measurement systems that resulted in data that could not be reported to the TSSWCB. (attach another page if necessary):

Submitted by: Date Submitted to TSSWCB:

TAG Series:

Date Range:

Data Source:

Comments (attach file if necessary):

Appendix F

TIAER Flow Measurement SOP